

AD-A144 369

UPDATE TO THE FREE FLOATING TWO-DIMENSIONAL EXTENSIBLE  
CABLE SYSTEM MODEL (FF2E)(U) NAVAL AVIONICS CENTER  
INDIANAPOLIS IN K L HOUSER 18 MAY 84 NAC-TR-2359

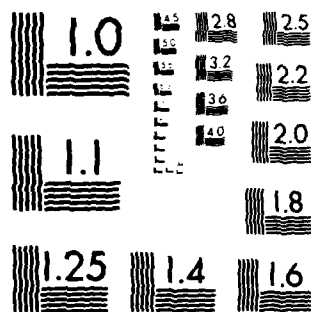
1/1

UNCLASSIFIED

F/G 20/4

NL


END  
DATE  
FILMED  
9 84  
DTIC



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963-A

TR-2359

(12)

AD-A144 369

**UPDATE TO  
THE FREE FLOATING  
TWO-DIMENSIONAL  
EXTENSIBLE CABLE SYSTEM  
MODEL (FF2E)**



**KEVIN L. HOUSER  
ANTISUBMARINE WARFARE  
ENGINEERING BRANCH  
NAVAL AVIONICS CENTER  
INDIANAPOLIS, IN 46218  
18 MAY 1984**

**DTIC**  
**SELECTED**  
**S** **AUG 8 1984**  
**A**

DTIC FILE COPY

Approved for public release; distribution unlimited.

84 08 07 052

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NAC-TR-2359	2. GOVT ACCESSION NO. AD-A144	3. RECIPIENT'S CATALOG NUMBER 36.9
4. TITLE (and Subtitle) Update to the Free Floating Two-Dimensional Extensible Cable System Model (FF2E)		5. TYPE OF REPORT & PERIOD COVERED Final
7. AUTHOR(s) Kevin L. Houser		6. PERFORMING ORG. REPORT NUMBER
8. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Avionics Center Anti-Submarine Warfare Engineering Branch 955 Indianapolis, IN 46218		9. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 18 May 1984
		13. NUMBER OF PAGES 20
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) 1. Free Floating Cable System, 2. Sonobuoy, 3. Ocean Current Profile		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Free Floating Two-Dimensional Extensible Cable System Model (FF2E) was modified to account for velocity dependent drag forces on surface floats, non-linear stretch characteristics of cable, and true current versus depth calculation relative to the 90% ocean current profile. Two new subroutines incorporating interpolation schemes for empirical data have been added to the program. A third subroutine has been modified to allow direct calculation of current versus depth when the 90% current profile is used.		

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 68 IS OBSOLETE  
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UPDATE TO THE FREE FLOATING TWO-DIMENSIONAL EXTENSIBLE CABLE SYSTEM  
MODEL (FF2E)

NAVAL AVIONICS CENTER  
6000 E. 21ST STREET  
INDIANAPOLIS, IN 46218

PREPARED BY:

Kevin Houser  
KEVIN L. HOUSER

APPROVED BY:

Michael L. Haben  
MICHAEL L. HABEN



A-1

TABLE OF CONTENTS

	Page(s)
PURPOSE . . . . .	1
BACKGROUND. . . . .	1
OBJECTIVE . . . . .	1
SUMMARY OF CHANGES. . . . .	2
DISCUSSION. . . . .	2-6
INPUT DATA FORMAT AND DESCRIPTION . . . . .	7-12
REFERENCES. . . . .	13
APPENDIX I-FF2E LISTING . . . . .	14

UPDATE TO THE FREE FLOATING TWO-DIMENSIONAL EXTENSIBLE CABLE SYSTEM  
MODEL (FF2E)

PURPOSE

The purpose of this report is to explain the modifications made to the FF2E computer program to more accurately predict operational behavior of a drifting sonobuoy. Each modification will be discussed in detail including the new data inputs required to execute the program.

BACKGROUND

The FF2E computer program, references (1) and (2), was developed to predict the steady-state behavior of a cable system in an ocean environment. The program, as referenced in sonobuoy specifications, is used to predict the operating conditions of a sonobuoy. The two conditions generally emphasized are the operating depth of the hydrophone and the velocity of the hydrophone, relative to the current at the hydrophone's operating depth. For the purpose of this report, the relative hydrophone velocity will be referred to as the "flow velocity". The flow velocity for a sonobuoy design, in a given two-dimensional current profile, can be predicted as a function of the drag characteristics of the sonobuoy system. The predicted flow velocity is used to establish the test scenario for evaluating mechanically-induced noise. The level of mechanically-induced noise is a function of the flow velocity; therefore, an accurate flow prediction is required. With increasing emphasis being placed on reducing mechanically-induced noise, a more accurate model of a drifting sonobuoy is required.

OBJECTIVE

The objective of the task was to develop a more accurate means of modeling the behavior of a drifting sonobuoy. The task was divided into four major areas:

- a. Develop a subroutine which would find the true drag force on a surface unit given the flow velocity past the surface unit.
- b. Incorporate a change to the program which will allow the use of the analytical formula for the 90% ocean current profile of reference (3) to calculate flow velocity at any given depth.
- c. Add a subroutine which would compensate for the non-linear stretch characteristics of a cable or compliance in the sonobuoy suspension system.
- d. Make a modification to the subroutine "BODY" which corrects an inherent interpolation error.

### SUMMARY OF CHANGES

a. An interpolation scheme has been included in the subroutine "VAR" which allows the true drag force on a surface unit to be found. This is accomplished by interpolation of empirically measured values relating drag forces relative to flow velocities on the surface unit. If no table of values is to be input, the program will operate as previously written.

b. A modification to the subroutine "CUR" has been incorporated which will allow direct calculation of flow velocity given any depth in the 90% ocean current profile. When this profile is used, input of current velocity data points is not required. If the 90% profile is not used, the program will operate as previously written, by interpolation between current velocity data points.

c. The subroutine "STRETH", identified by reference (4), has been added to the program to account for the non-linear stretching characteristics of cables and compliances. This subroutine utilizes an input table of tension values versus AE values, where "A" is equal to the cross-sectional area and "E" is equal to Young's Modulus. If a cable has a constant value of AE the program will operate as previously written. The input for AE has been altered to allow for the input of tables.

d. A modification has been made to the subroutine "BODY" which corrects an error in output when a velocity or angle value falls within the first segment of the lift drag table.

### DISCUSSION

Because of Fleet operational requirements, increased emphasis has been placed on reducing mechanically induced noise in sonobuoys. Therefore, emphasis is being placed on upgrading and refining the analytical tools used to evaluate the suspension systems.

Due to this fact, modifications to the FF2E program have been incorporated to create a more accurate prediction of a drifting sonobuoy. In the following paragraphs each modification will be discussed. Included in this report is an improved data input scenario which contains the added input parameters for the modifications. In Appendix I there is a complete listing of the improved FF2E program.

#### SUBROUTINE "VAR"

In the present version of the FF2E program, drag of the surface unit is determined using the flow velocity past the unit at a depth of one-half the draft, where the draft is equal to the distance from sea surface to the bottom of the surface unit. As the program iterates, it searches for an equilibrium

of the buoyancy of the upper unit and the effective weight of the hydrophone and suspension system by varying the drift velocity and sonobuoy draft. Because the FF2E program uses a mathematical equation to model the drag force of the upper unit, the calculated drag force may not exactly model the empirically derived drag force of the actual hardware. This inherent error creates a false equilibrium of forces and ultimately could effect the flow velocity of the hydrophone.

The subroutine "VAR" was added to allow the true drag of the surface unit to be found given the relative flow of the upper unit. This subroutine utilizes a reference table of values which contain measured drag forces versus flow velocities. In each iteration of the subroutine "STEADY" the subroutine "VAR" is called with values of drag, flow, draft, diameter, and drag coefficient. Using the value of flow equal to the flow velocity at one-half the draft, the subroutine finds the drag force by interpolating between empirically derived data points. This value of drag force is then compared with the calculated drag force. If the difference between these two values is less than .001 lbs., the program will return and continue with the iterations of the subroutine "STEADY". For differences greater than .001 lbs., the subroutine calculates the surface unit drag coefficient based on the empirically measured drag force value. This coefficient is then used to vary the original surface unit drag coefficient until correlation between the empirically measured drag force and the calculated drag force is achieved.

#### DATA INPUT CHANGES FOR SUBROUTINE "VAR"

Three variables have been added to the data input scheme. The first is NFOSB. NFOSB is the number of drag forces to be entered in the drag versus flow velocity table. A maximum of 15 values may be entered in the table. The second variable is FOSB(k), where k=1 to NFOSB. FOSB(k) corresponds to the drag force values to be input in the table. FOSB(k) should range from 0 lbs. to a magnitude which is greater than the expected drag on the surface unit. The final variable is VOSB(k), which is the flow velocity in knots that corresponds to the force values entered in FOSB(k). If no table is to be entered for the surface unit drag, then NFOSB should be set equal to zero, and no values for FOSB(k) and VOSB(k) are entered.

#### DATA OUTPUT FOR SUBROUTINE "VAR"

The program will print out the corresponding value of FOSB and VOSB in a table format. After the program has reached the steady state solution, it will print out the drag force on the surface unit as, "the computed horizontal component of tension". Also, the program prints out, "the CD of the surface unit", and "the flow past the surface unit".

## SUBROUTINE CUR

In the present FF2E program, subroutine "CUR" is called to perform a linear interpolation of the input current profile points. The purpose of this subroutine is to find a flow velocity for a given depth in the ocean profile. Depending on the step-size and number of current profile points entered, the amount of error in the interpolation of depths close to the surface will vary, since the current profile is not a straight line at shallow depths.

In the modified program, the analytical formula which describes the 90% profile, has been added to subroutine "CUR". If the user wishes to use the 90% profile, then the number of current profile points, NCUR, must be set equal to zero and XX(I) and YY(I) values are not entered. If NCUR is not zero, then the values for the current profile must be entered.

## SUBROUTINE "STRETH"

The present FF2E computer program assumes that the cable and compliance of a sonobuoy suspension system will have linearly stretching characteristics. In the past, the problem of a non-linear stretching cable has been over-ridden by inputting the stretched length of the cable into FLC(k) and choosing an AE value of high magnitude.

In the modified program, subroutine "STRETH", identified by reference (4), has been added to account for cables with non-linear stretch characteristics. The subroutine utilizes a reference table of values which relates cable tension to a value of AE. The AE value is calculated from the following equation:

$$AE = \frac{L_0 (T - T_{ref})}{L - L_0}$$

L - L<sub>0</sub>

Where,

A = cross sectional area (ft<sup>2</sup>)

E = Young's Modulus (lb/ft<sup>2</sup>)

L = stretched length of cable (ft)

L<sub>0</sub> = unstretched length of cable (ft)

T = tension applied to cable (lb)

T<sub>ref</sub> = reference tension of unstretched cable (lb)

## DATA INPUT CHANGES FOR "STRETH"

Four variables have been added to the input data parameters. The first is NAE which corresponds to the number of points to be entered for the relation of tension to AE for each cable and compliance. NAE has a range from 1 to 15. FAE(I,K) and AE(I,K) are the corresponding tension and AE values for a cable over which the tension-strain curve is non-linear, where I=1 to NCAB and K=1 to NAE. For cables with a linear tension-strain curve, NAE will be set equal to 1, and the fourth variable, AE(I,1) would be equal to a constant AE value. Values for AE should be entered for the entire range of tensions over which the tension-strain curve is non-linear. For tension values outside the range of the table, AE will be set equal to the endpoint value.

## DATA OUTPUT CHANGES FOR "STRETH"

The program will print out the corresponding Tension-AE values in tabular format as they are entered in the input. For cables with linear stretch characteristics the constant value of AE will be printed out.

## SUBROUTINE "BODY"

A modification to the subroutine "BODY", reference (4), has been provided which corrects an error in this subroutine. Previously, when a velocity or angle value fell within the first segment of the lift drag table, the first value of the table was chosen rather than interpolating between the first and second values of the table. As an example, assume the following table is in the program:

ANGLE									
		0			10			20	
V E L O C I T Y		-	L	D	L	D		L	D
	1	-	4	1	7	4		10	7
	2	-	5	2	8	5		11	8
	3	-	6	3	9	6		12	9
		-							

The new data points may be computed as follows:

STEP 1: Determine lift at the desired velocity and at a given angle by interpolation

$$\frac{(V_3 - V_1)(V_2 - V_1)}{L_3 - L_1} (V_2 - V_1) + L_1 = L_2$$

where  $V_2$  = desired velocity

$V_1$  = next lowest velocity data point

$V_3$  = next highest velocity data point

$L_2$  = calculated lift for desired velocity

$L_1$  = lift value for next lowest velocity

$L_3$  = lift value for next highest velocity

Example:  $\frac{(2-1)(1.5-1)}{(5-4)} + 4 = L_2 = 4.5$  for angle =  $0^\circ$ , and velocity = 1.5

$\frac{(2-1)(1.5-1)}{(8-7)} + 7 = L'_2 = 7.5$  for angle =  $10^\circ$ , and velocity = 1.5

STEP 2: Determine lift for the desired angle at the desired velocity by interpolation:

$$\frac{(L'_2 - L_2)(A_2 - A_1)}{A_3 - A_1} + L_2 = L$$

where  $A_1$  = next lowest angle in table

$A_3$  = next highest angle in table

$L$  = value for lift at the desired velocity and angle

Example:  $\frac{(7.5 - 4.5)(10 - 0)}{5 - 0} + 4.5 = 6$  for angle =  $5^\circ$  and velocity = 1.5

STEP 3: Compute drag by substituting "D" for "L" and repeating steps 1 and 2.

The new data points for the example are found to be lift = 6 and drag = 3 for velocity = 1.5 and angle =  $5^\circ$ .

INPUT DATA FORMAT AND DESCRIPTION

A description of the input parameters of the modified FF2E program is shown below:

CARD 1

COLUMN 1-3

1. NCASES - number of sets of data to be ran. NCASES is set equal to 1 for one set of data to be ran. NCASES is an integer.

CARD 2

COLUMN 1-3

2. NCUR - number of current profile points to be entered. The maximum number of points is 30. If NCUR=0, the 90% profile is assumed. NCUR is an integer.

COLUMN 4-6

3. NCAB - number of cable segments bounded by endpoints or system components. NCAB is an integer.

COLUMN 7-9

4. NHPHS - number of hydrophones. NHPHS is an integer.

COLUMN 10-12

5. NTAB - number of lift/drag tables. If no tables are used then NTAB=0. NTAB is an integer.

CARD 3

COLUMN 1-12

6. DAI - diameter of buoy antenna in inches. DAI is a floating point number.

COLUMN 13-24

7. LA - length of buoy antenna in feet. LA is a floating point number.

COLUMN 25-36

8. CDA - drag coefficient in air of buoy antenna. CDA is a floating point number.

COLUMN 37-48

9. TBH - horizontal component of tension in pounds applied to lower unit. TBH is a floating point number.
10. TBV - vertical component of tension in pounds applied to lower unit. TBV is a floating point number. TBH, TBV should equal 0. for free floating system.

CARD 4

COLUMN 1-12

11. DB - diameter of cylindrical buoy in feet. DB is a floating point number.

COLUMN 13-24

12. LB - length of cylindrical buoy in feet. LB is a floating point number.

COLUMN 25-36

13. CDB1 - drag coefficient of submerged portion of surface buoy. CDB1 is a floating point number.

COLUMN 37-48

14. CDB2 - drag coefficient of surface buoy above sea surface. CDB2 is a floating point number.

COLUMN 49-60

15. WB - weight of surface buoy in air in pounds. WB is a floating point number.

COLUMN 61-72

16. UWINDK - velocity of wind in knots. UWINDK is a floating point number.

CARD 5

COLUMN 1-3

17. NFOSB - number of values on the force vs. flow curve. NFOSB = 0 to 15 and is an integer.

CARD 6

COLUMN 1-12, 13-24, etc.

18. FOSB(K) - force values on the force/flow curve for the surface unit in pounds. FOSB(k) are floating point numbers, where K=1, NFOSB.

CARD 7

COLUMN 1-12, 13-24, etc.

19. VOSB(K) - flow values on the force/flow curve for the surface unit in knots. VOSB(K) are floating point numbers, where K=1, NFOSB.

Note: For variables 18 and 19, a maximum of 6 values may be read in on one card. As many additional cards as required may be used.

CARD 8

COLUMN 1-12

20. CDAPK - drag coefficient times the normal drag area of package hung just below the surface buoy in feet squared. CDAPK is a floating point number.

COLUMN 13-24

21. WPAK - wet weight of package hung just below the surface buoy in pounds. WPAK is a floating point number.

CARD 9

COLUMN 1-12, 13-24, etc.

22. FLC(K) - length of each cable in feet. FLC(K) is a floating point number, where K=1, NCAB.

CARD 10

COLUMN 1-12, 13-24, etc.

23. NPR(K) - number of segments each cable is divided. NPR(K) are integer values, where K=1, NCAB.

CARD 11

COLUMN 1-12, 13-24, etc.

24. DCI(K) - diameter of each cable in inches. DCI(K) are floating point numbers, where K=1, NCAB.

CARD 12

COLUMN 1-12, 13-24, etc.

25. CVFAC(K) - conversion factor for non-circular cross section of cable. CVFAC is a floating point number, where K=1, NCAB.

CARD 13

COLUMN 1-12, 13-24, etc.

26. WC(K) - weight per unit length of each cable in water in pounds per foot. WC(K) are floating point numbers where K=1, NCAB.

CARD 14

COLUMN 1-12, 13-24, etc.

27. CDC(K) - coefficient of drag on each cable normal to the cable. CDC(K) are floating point numbers, where K=1, NCAB.

CARD 15

COLUMN 1-12, 13-24, etc.

28. TREF(K) - reference tension in each cable in pounds. If FLC(K) is an unstretched length, set TREF(K) = 0. TREF(K) are floating point numbers.

CARD 16

COLUMN 1-12, 13-24, etc.

29. (K) - Poisson's ratio for each cable. P(K) are floating point numbers.

CARD 17

COLUMN 1-3

30. NAE(K) - number of points on the tension/AE curve for each cable. NAE(K) are integers. For a cable without a table NAE=1.

CARD 18

COLUMN 1-12, 13-24, etc.

31.  $AE(K,I)$  - AE value for cable with linear stretch characteristics with  $NAE=1$ .  $AE(K,I)$  is a floating point number.

CARD 18a

COLUMN 1-12, 13-24, etc.

32.  $F AE(K,I)$  - tension values over which AE is changing in pounds.  $F AE(K,I)$  are floating point numbers, where  $K=1, NCAB$  and  $I=1, NAE$ .

CARD 18b

COLUMN 1-12, 13-24, etc.

33.  $AE(K,I)$  - corresponding values of AE relative to the values of card 18a.  $AE(K,I)$  are floating point numbers.

CARD 19

COLUMN 1-12, 13-24, etc.

34.  $CDABD(K)$  - Drag coefficient times normal drag area of body at the bottom of each cable in feet squared.  $CDABD(K)$  are floating point numbers, where  $K=1, NCAB$ .

CARD 20

COLUMN 1-12, 13-24, etc.

35.  $WBD(K)$  - wet weight of body at the bottom of each cable in pounds.  $WBD(K)$  are floating point numbers, where  $K=1, NCAB$ .

CARD 21

COLUMN 1-3, 4-6, etc.

36.  $NBOD(K)$  - lift/drag table number which applies to the body at the bottom of each cable. If no body table, then  $NBOD=0$ .  $NBOD(K)$  are integer numbers, where  $K=1, NCAB$ .

CARD 22

COLUMN 1-2, 13-24, etc.

37.  $XX(I)$  - depth of each current point in feet.  $XX(I)$  are floating point numbers, where  $I=1, NCUR$ .

CARD 23

COLUMN 1-12, 13-24, etc.

38. YY(I) - current velocity at each point corresponding to depths of XX(I). Velocities are in knots and are floating point numbers, where I=1, NCUR.

Note: If NCUR=0, then values for XX(I), YY(I) are not input.

CARD 24

COLUMN 1-3

39. NPHI(N) - number of angle values for which lift/drag tables are generated. NPHI(N) are integer numbers.

COLUMN 4-6

40. NU(N) - number of velocity values for which lift/drag tables are generated. NU(N) are integer numbers.

CARD 25

41. PHIM(N,I) - angle in degrees of suspension cable from vertical for which lift/drag forces are generated. PHIM(N,I) are floating point numbers.

CARD 26

COLUMN 1-12, 13-24, etc.

42. U(N,J) - Velocity in knots for which lift/drag forces are generated. U(N,J) are floating point numbers.

CARD 27

COLUMN 1-12, 13-24, etc.

43. DDRAG(M) - drag values in pounds for a velocity and angle. DDRAG(M) are floating point numbers.

CARD 28

COLUMN 1-12, 13-24, etc.

44. DLIFT(M) - lift values in pounds for a velocity and angle. DLIFT(M) are floating point numbers.

Note: For variables 39 to 42, N=1 to NTAB, I=1 to NPHI(N), and J=1 to NU(N). For variables 43 and 44, M=1 to NP, where NP=NU(N) times NPHI(N).

REFERENCES

1. Wang, Henry T., and Moran, Thomas L., "Analysis of the Two-Dimensional Steady-State Behavior of Extensible Free Floating Cable Systems", NSRDC Report No. 3721, Oct 1971.
2. McEachern, James F., "A Modification to the Free Floating Extensible Cable System Computer Model (FF2E) to Consider Lift and Drag Forces on Intermediate Bodies", NADC Report No. NADC80178-30, 7 May 1980.
3. Holler, R. A. "Ocean Current Profile Definition", Research on Sonobuoy Configuration Annual Report 1976, pp 109-151, Naval Air Development Center, 1 Sep 1977.
4. Magnavox Report, "Updates and Inputs to the FF2E Cable Model", 20 August 1979.

NAC-TR-2359

APPENDIX I  
FF2E LISTING



```

362C LB = LENGTH OF BUOY (FT)
363C CDB1 = DRAG COEF. OF SUBMERGED PORTION OF BUOY
364C CDB2 = DRAG COEF. OF BUOY PORTION ABOVE SEA SURFACE
365C WB = WEIGHT OF SURFACE BUOY IN AIR (LBS)
366C UWINDR = VELOCITY OF WIND (KNOTS)
367C
368C PRINT.
369C PRINT. " INPUT DB, LB, CDB1, CDB2, WB, UWINDR "
370C
380C 8 READ(5,500) DB, LB, CDB1, CDB2, WB, UWINDR
381C
389C IF (R.EQ.0) GO TO 10
390C
391C PRINT.
392C NFOSB = # OF POINTS ON THE FORCE/FLOW CURVE OF SURFACE BUOY
393C PRINT. " INPUT NFOSB "
394C
400C 10 READ(5,512) NFOSB
401C
402C N=NFOSB
403C IF (N.EQ.0) GO TO 16
404C
405C IF (R.EQ.0) GO TO 12
406C
407C PRINT.
408C FOSB = FORCE VALUES ON FORCE/FLOW CURVE (LBS)
409C PRINT. " INPUT FOSB(K) "
410C
411C 12 READ(5,502) (FOSB(K), K=1, N)
412C
413C IF (R.EQ.0) GO TO 14
414C
415C PRINT.
416C VOSB = FLOW VALUES ON THE FORCE/FLOW CURVE (KNOTS)
417C PRINT. " INPUT VOSB(K) "
418C
419C 14 READ(5,502) (VOSB(K), K=1, N)
420C
421C 15 IF (R.EQ.0) GO TO 18
422C
423C PRINT.
424C CDAPK = DRAG COEF. TIMES DRAG AREA OF PACKAGE BELOW SURFACE BUOY (FT*
425C FT)
426C WPAK = NET WEIGHT OF PACKAGE BELOW SURFACE BUOY (LBS)
427C PRINT. " INPUT CDAPK, WPAK "
428C
429C 18 READ(5,500) CDAPK, WPAK
430C
431C IF (R.EQ.0) GO TO 20
432C
433C FLC = LENGTH OF EACH CABLE (FT)
434C PRINT.
435C PRINT. " INPUT FLC(K) "
436C
437C 20 READ(5,502) (FLC(K), K=1, NCAB)
438C
439C IF (R.EQ.0) GO TO 22
440C
441C NPR = # OF SEGMENTS INTO WHICH EACH CABLE IS DIVIDED
442C PRINT.
443C PRINT. " INPUT NPR(K) "
444C
445C 22 READ(5,512) (NPR(K), K=1, NCAB)
446C
447C IF (R.EQ.0) GO TO 24
448C
449C
450C

```

```

589C      DCI = DIAMETER OF EACH CABLE (IN)
590C      PRINT,
591C      PRINT," INPUT DCI(K)"
592C      24 READ(5,500) (CDC(K),K=1,NCAB)
593C      610
594C      IF(R.EQ.0) GO TO 26
595C
596C      CVFAC = CONVERSION FACTOR FOR NON-CIRCULAR CROSS-SECTION OF CABLE
597C      PRINT,
598C      PRINT," INPUT CVFAC(K)"
599C      25 READ(5,500) (CVFAC(K),K=1,NCAB)
600C      610
601C      IF(R.EQ.0) GO TO 28
602C
603C      WC = WEIGHT PER FOOT OF EACH CABLE IN WATER (LB/FT)
604C      PRINT,
605C      PRINT," INPUT WC(K)"
606C      26 READ(5,500) (WC(K),K=1,NCAB)
607C      610
608C      IF(R.EQ.0) GO TO 30
609C
610C      CDC = DRAG COEF. OF EACH CABLE
611C      PRINT,
612C      PRINT," INPUT CDC(K)"
613C      30 READ(5,500) (CDC(K),K=1,NCAB)
614C      700
615C      IF(R.EQ.0) GO TO 32
616C
617C      TREF = REFERENCE TENSION IN EACH CABLE (LB)
618C      PRINT,
619C      PRINT," INPUT TREF(K)"
620C      32 READ(5,502) (TREF(K),K=1,NCAB)
621C      710
622C      IF(R.EQ.0) GO TO 34
623C
624C      P = POISSON RATIO FOR EACH CABLE
625C      PRINT,
626C      PRINT," INPUT P(K)"
627C      34 READ(5,500) (P(K),K=1,NCAB)
628C      760
629C      IF(R.EQ.0) GO TO 36
630C
631C      NAE = # OF POINTS ON THE TENSION/AE CURVE
632C      PRINT,
633C      PRINT," INPUT NAE(K)"
634C      36 READ(5,612) (NAE(K),K=1,NCAB)
635C      800
636C      DO 45 K=1,NCAB
637C         N=NAE(K)
638C         IF(M.ST.1) GO TO 40
639C
640C         IF(P.EQ.0) GO TO 38
641C         INSERT ONE VALUE PER LINE
642C         PRINT,
643C         PRINT," INPUT AE(K,1)"
644C         38 READ(5,502) AE(K,1)
645C
646C         GO TO 46
647C
648C
649C
650C
651C
652C
653C
654C
655C
656C
657C
658C
659C
660C
661C
662C
663C
664C
665C
666C
667C
668C
669C
670C
671C
672C
673C
674C
675C
676C
677C
678C
679C
680C
681C
682C
683C
684C
685C
686C
687C
688C
689C
690C
691C
692C
693C
694C
695C
696C
697C
698C
699C
700C
701C
702C
703C
704C
705C
706C
707C
708C
709C
710C
711C
712C
713C
714C
715C
716C
717C
718C
719C
720C
721C
722C
723C
724C
725C
726C
727C
728C
729C
730C
731C
732C
733C
734C
735C
736C
737C
738C
739C
740C
741C
742C
743C
744C
745C
746C
747C
748C
749C
750C
751C
752C
753C
754C
755C
756C
757C
758C
759C
760C
761C
762C
763C
764C
765C
766C
767C
768C
769C
770C
771C
772C
773C
774C
775C
776C
777C
778C
779C
780C
781C
782C
783C
784C
785C
786C
787C
788C
789C
790C
791C
792C
793C
794C
795C
796C
797C
798C
799C
800C
801C
802C
803C
804C
805C
806C
807C
808C
809C
810C
811C
812C
813C
814C
815C
816C
817C
818C
819C
820C
821C
822C
823C
824C
825C
826C
827C
828C
829C
830C
831C
832C
833C
834C
835C
836C
837C
838C
839C
840C
841C
842C
843C
844C
845C
846C
847C
848C
849C
850C
851C
852C
853C
854C
855C
856C
857C
858C
859C
860C
861C
862C
863C
864C
865C
866C
867C
868C
869C
870C
871C
872C
873C
874C
875C
876C
877C
878C
879C
880C
881C
882C
883C
884C
885C
886C
887C
888C
889C
890C
891C
892C
893C
894C
895C
896C
897C
898C
899C
900C

```

```

070 40 CONTINUE
      IF (P.EQ.0) GO TO 42
      PRINT,
      881C
      882C
      883C
      884C
      885C
      886C
      887C
      888C
      889C
      890C
      891C
      892C
      893C
      894C
      895C
      896C
      897C
      898C
      899C
      900C
      901C
      902C
      903C
      904C
      905C
      906C
      907C
      908C
      909C
      910C
      911C
      912C
      913C
      914C
      915C
      916C
      917C
      918C
      919C
      920C
      921C
      922C
      923C
      924C
      925C
      926C
      927C
      928C
      929C
      930C
      931C
      932C
      933C
      934C
      935C
      936C
      937C
      938C
      939C
      940C
      941C
      942C
      943C
      944C
      945C
      946C
      947C
      948C
      949C
      950C
      951C
      952C
      953C
      954C
      955C
      956C
      957C
      958C
      959C
      960C
      961C
      962C
      963C
      964C
      965C
      966C
      967C
      968C
      969C
      970C
      971C
      972C
      973C
      974C
      975C
      976C
      977C
      978C
      979C
      980C
      981C
      982C
      983C
      984C
      985C
      986C
      987C
      988C
      989C
      990C
      991C
      992C
      993C
      994C
      995C
      996C
      997C
      998C
      999C
      1000C
      1001C
      1002C
      1003C
      1004C
      1005C
      1006C
      1007C
      1008C
      1009C
      1010C
      1011C
      1012C
      1013C
      1014C
      1015C
      1016C
      1017C
      1018C
      1019C
      1020C
      1021C
      1022C
      1023C
      1024C
      1025C
      1026C
      1027C
      1028C
      1029C
      1030C
      1031C
      1032C
      1033C
      1034C
      1035C
      1036C
      1037C
      1038C
      1039C
      1040C
      1041C
      1042C
      1043C
      1044C
      1045C
      1046C
      1047C
      1048C
      1049C
      1050C
      1051C
      1052C
      1053C
      1054C
      1055C
      1056C
      1057C
      1058C
      1059C
      1060C
      1061C
      1062C
      1063C
      1064C
      1065C
      1066C
      1067C
      1068C
      1069C
      1070C
      1071C
      1072C
      1073C
      1074C
      1075C
      1076C
      1077C
      1078C
      1079C
      1080C
      1081C
      1082C
      1083C
      1084C
      1085C
      1086C
      1087C
      1088C
      1089C
      1090C
      1091C
      1092C
      1093C
      1094C
      1095C
      1096C
      1097C
      1098C
      1099C
      1100C
      1101C
      1102C
      1103C
      1104C
      1105C
      1106C
      1107C
      1108C
      1109C
      1110C
      1111C
      1112C
      1113C
      1114C
      1115C
      1116C
      1117C
      1118C
      1119C
      1120C
      1121C
      1122C
      1123C
      1124C
      1125C
      1126C
      1127C
      1128C
      1129C
      1130C
      1131C
      1132C
      1133C
      1134C
      1135C
      1136C
      1137C
      1138C
      1139C
      1140C
      1141C
      1142C
      1143C
      1144C
      1145C
      1146C
      1147C
      1148C
      1149C
      1150C
      1151C
      1152C
      1153C
      1154C
      1155C
      1156C
      1157C
      1158C
      1159C
      1160C
      1161C
      1162C
      1163C
      1164C
      1165C
      1166C
      1167C
      1168C
      1169C
      1170C
      1171C
      1172C
      1173C
      1174C
      1175C
      1176C
      1177C
      1178C
      1179C
      1180C
      1181C
      1182C
      1183C
      1184C
      1185C
      1186C
      1187C
      1188C
      1189C
      1190C
      1191C
      1192C
      1193C
      1194C
      1195C
      1196C
      1197C
      1198C
      1199C
      1200C
      1201C
      1202C
      1203C
      1204C
      1205C
      1206C
      1207C
      1208C
      1209C
      1210C
      1211C
      1212C
      1213C
      1214C
      1215C
      1216C
      1217C
      1218C
      1219C
      1220C
      1221C
      1222C
      1223C
      1224C
      1225C
      1226C
      1227C
      1228C
      1229C
      1230C
      1231C
      1232C
      1233C
      1234C
      1235C
      1236C
      1237C
      1238C
      1239C
      1240C
      1241C
      1242C
      1243C
      1244C
      1245C
      1246C
      1247C
      1248C
      1249C
      1250C
      1251C
      1252C
      1253C
      1254C
      1255C
      1256C
      1257C
      1258C
      1259C
      1260C
      1261C
      1262C
      1263C
      1264C
      1265C
      1266C
      1267C
      1268C
      1269C
      1270C
      1271C
      1272C
      1273C
      1274C
      1275C
      1276C
      1277C
      1278C
      1279C
      1280C
      1281C
      1282C
      1283C
      1284C
      1285C
      1286C
      1287C
      1288C
      1289C
      1290C
      1291C
      1292C
      1293C
      1294C
      1295C
      1296C
      1297C
      1298C
      1299C
      1300C
      1301C
      1302C
      1303C
      1304C
      1305C
      1306C
      1307C
      1308C
      1309C
      1310C
      1311C
      1312C
      1313C
      1314C
      1315C
      1316C
      1317C
      1318C
      1319C
      1320C
      1321C
      1322C
      1323C
      1324C
      1325C
      1326C
      1327C
      1328C
      1329C
      1330C
      1331C
      1332C
      1333C
      1334C
      1335C
      1336C
      1337C
      1338C
      1339C
      1340C
      1341C
      1342C
      1343C
      1344C
      1345C
      1346C
      1347C
      1348C
      1349C
      1350C
      1351C
      1352C
      1353C
      1354C
      1355C
      1356C
      1357C
      1358C
      1359C
      1360C
      1361C
      1362C
      1363C
      1364C
      1365C
      1366C
      1367C
      1368C
      1369C
      1370C
      1371C
      1372C
      1373C
      1374C
      1375C
      1376C
      1377C
      1378C
      1379C
      1380C
      1381C
      1382C
      1383C
      1384C
      1385C
      1386C
      1387C
      1388C
      1389C
      1390C
      1391C
      1392C
      1393C
      1394C
      1395C
      1396C
      1397C
      1398C
      1399C
      1400C
      1401C
      1402C
      1403C

```

```

1140C NPHI = 0 OF ANGLE VALUES IN A LIFT/DRAG TABLE
1141C NU = 0 OF CURRENT VALUES IN A LIFT/DRAG TABLE
1142C
1143C PRINT, " INPUT NPHI(N),NU(N)"
1144C
1145C PRINT, " INPUT NPHI(N),NU(N)"
1146C
1147C READ(5,512) NPHI(N),NU(N)
1148C
1149C NPT=NPHI(N)
1150C
1151C NUT=NU(N)
1152C
1153C IF(R.EQ.0) GO TO 62
1154C
1155C PHIM = ANGLE FROM VERTICAL IN THE LIFT/DRAG TABLE
1156C
1157C PRINT, " INPUT PHIM(N,I)"
1158C
1159C READ(5,502) (PHIM(N,I),I=1,NPT)
1160C
1161C 62 READ(5,502) (PHIM(N,I),I=1,NPT)
1162C
1163C IF(R.EQ.0) GO TO 64
1164C
1165C U = VELOCITIES IN THE LIFT/DRAG TABLES (KNOTS)
1166C
1167C PRINT, " INPUT U(N,J)"
1168C
1169C PRINT, " INPUT U(N,J)"
1170C
1171C READ(5,502) (U(N,J),J=1,NUT)
1172C
1173C NP=NPHI(N)=NU(N)
1174C
1175C IF(R.EQ.0) GO TO 66
1176C
1177C DDAG = DRAG VALUES FOR GIVEN VELOCITY AND ANGLE (LBS)
1178C
1179C PRINT, " INPUT DDAG(N)"
1180C
1181C PRINT, " INPUT DDAG(N)"
1182C
1183C READ(5,500) (DDAG(N),M=1,NP)
1184C
1185C 66 READ(5,500) (DDAG(N),M=1,NP)
1186C
1187C IF(R.EQ.0) GO TO 68
1188C
1189C DLIFT = LIFT VALUES FOR GIVEN VELOCITY AND ANGLE (LBS)
1190C
1191C PRINT, " INPUT DLIFT(N)"
1192C
1193C PRINT, " INPUT DLIFT(N)"
1194C
1195C READ(5,500) (DLIFT(N),M=1,NP)
1196C
1197C DO 69 J=1,NUT
1198C
1199C SGU = SGU+U(N,I)
1200C
1201C DO 69 J=1,NPT
1202C
1203C INDX=J+(I-1)*NPHI(N)
1204C
1205C D(N,I,J)= DDAG(INDX)
1206C
1207C 69 L(N,I,J)=DLIFT(INDX)
1208C
1209C COMPUTE AVERAGE CDA FOR BODY FROM TABULATED DATA
1210C
1211C SGU=SGU
1212C
1213C SGU= SGU+1.688/NU(N)
1214C
1215C DO 71 ID=1,NP
1216C
1217C SCD =SGD+DDAG(ID)
1218C
1219C CDINIT(N)=2.*SGDA/(1.9985*SGU**2)
1220C
1221C 73 CDINIT(N)=2.*SGDA/(1.9985*SGU**2)
1222C
1223C EPSLON=.0001
1224C
1225C EP2=.0001
1226C
1227C FTANG=.020
1228C
1229C DA=DA1/12.0
1230C
1231C DO 77 J=1,NCAB
1232C
1233C DC(J)=DC1(J)/12.
1234C
1235C ASSIGN INITIAL CDABD FROM AVERAGE TABULATED DRAG AND VELOCITY DATA
1236C
1237C IF(NBOD(J).LE.0)GO TO 77
1238C
1239C CDABD(J)=CDINIT(NBOD(J))
1240C
1241C 77 CONTINUE

```

```

1550 DO 119 ICASE=1,NCASES
1560C FIND THE MAXIMUM AND MINIMUM VALUES OF THE CURRENT
1570C TOTL=B
1580 DO 79 J=1,NCAB
1590C 79 TOTL=TOTL+FLC(J)
1600C TOTL=1.3*TOTL
1610C IF(INCUR .EQ. 0) GO TO 83
1620C UMAX=-1000.
1630C UMIN=1000.
1640C DO 81 I=1,NCUR
1650C IF(VVK(I).GT.UMAX) UMAX=VVK(I)
1660C IF(VVK(I).LT.UMIN) UMIN=VVK(I)
1670C IF(XX(I).GT.TOTL) GO TO 82
1680C CONTINUE
1690C 81 UMAX=1.600*UMAX
1700C 82 UMIN=1.600*UMIN
1710C IF(INCUR .GT. 0) GO TO 84
1720C 83 UMAX=-1.853
1730C UMIN=1.600*UMAX
1740C CALL CUR TO CALCULATE UMIN AT DEPTH-TOTL
1750C CALL CUR(TOTL,UMIN)
1760C CONTINUE
1770C 84 FORMAT(// " SURFACE UNIT DRAG...")
1780C 85 FORMAT(3X, " FORCE(LB) ".15F8.3)
1790C 86 FORMAT(3X, "VS. FLOW(KTS) ".15F8.3)
1800C 87 FORMAT(1H,64H*****LISTING OF CABLE AND OCEAN ENVIRONMENT CHARACTE
1810C 88 RISTICS*****")
1820C 89 FORMAT(1X,5X,13HD DIAMETER (FT),46X,F8.5 )
1830C 90 FORMAT(1X,17HSURFACE BUOY.....)
1840C 91 FORMAT(6X,24HD DIAMETER OF ANTENNA (IN),36X,F7.5)
1850C 92 FORMAT(6X,11H LENGTH (FT),44X,F12.5)
1860C 93 FORMAT(6X,11H LENGTH (FT),44X,F12.5)
1870C 94 FORMAT(6X,12H LENGTH OF ANTENNA (FT),37X,F8.5)
1880C 95 FORMAT(6X,45H DRAG COEFFICIENT FOR BUOY (SUBMERGED PORTION),15X,F7.
1890C 96 )
1900C 97 FORMAT(6X,44H DRAG COEFFICIENT FOR BUOY (SURFACED PORTION),16X,F7.5
1910C 98 )
1920C 99 FORMAT(6X,23H DRAG COEFFICIENT FOR ANTENNA,32X,F7.5)
1930C 100 FORMAT(1X,18HWIND SPEED (KNOTS),45X,F9.5)
1940C 101 FORMAT(1X,18HOCEAN PROFILE.....)
1950C 102 FORMAT(5X,1X,10HDEPTH (FT),10X,15HCURRENT (KNOTS))
1960C 103 FORMAT(1X,8X,F8.2,13X,F8.4)
1970C 104 FORMAT(4X, "MAXIMUM CURRENT (FT/S) = ".F8.4, "MINIMUM CURRENT
1980C 105 &(FT/S) = ".F8.4)
1990C 106 FORMAT(1X,5X,19HWEIGHT IN AIR (LBS),40X,F8.5)
2000C 107 FORMAT(1X)
2010C 108 FORMAT(1X, " THE TRUE 90% PROFILE IS ASSUMED")
2020C 109 FORMAT(1H,10HPUN NUMBER,1X,13)
2030C 110 FORMAT(1X,5X,21H BOTTOM HORIZONTAL TENSION (LBS),27X,F9.5)
2040C 111 FORMAT(1X,5X,21H BOTTOM VERTICAL TENSION (LBS),29X,F9.5)
2050C 112 FORMAT(1X,5X,16HCABLE PROPERTIES,84X,15H BODY PROPERTIES)
2060C 113 FORMAT(1X,3HUM,2X,10H LENGTH(FT),14X,10H REF(LBS))
2070C 114 83X,21HD DIAMETER,2X,10H WT/FT,LBS,2X,9H DRAG COEF,2X,
2080C 115 82H DRAG COEF,2X,10H WT/FT,LBS,2X,9H DRAG COEF,2X,
2090C 116 81H TABLE)
2100C 117 FORMAT(1X,12,F12.4,12X,F12.4,4F12.4,6.5X,F9.6,5X,F11.6,11.6,
2110C 118 83X,12)
2120C 119 FORMAT(1X,5X,21H NUMBER OF HYDROPHONES,27X,13)
2130C 120 FORMAT(6X,25H PACKAGE DRAG AREA (FT SQ),30X,F12.5)
2140C 121 WRITE(6,603)
2150C 122 FORMAT(6X,29H PACKAGE WEIGHT IN WATER (LBS),20X,F12.5)
2160C 123 FORMAT(// " CABLE ELASTICITY.....")
2170C 124 FORMAT(13/3X " CONST. AE ".F18.2)
2180C 125 FORMAT(13/3X " FORCE (LB) ".15F8.2)
2190C 126 FORMAT(3X "VS. AE

```

2180 634 FORMAT(7.26X,'28HBODY LIFT AND DRAG TABLE NO..13.52HLIFT(LBS),

2190 635 &DRAG(LBS) VS ANGLE(DEG) AND VELOCITY(KNOT)

2200 636 FORMAT(13X,6(F6.3,4HDEG..8X),F6.3,4HDEG..)

2210 637 FORMAT(13X,6(F6.3,4HDEG..8X))

2220 638 FORMAT(13X,5(F6.3,4HDEG..8X))

2230 639 FORMAT(13X,4(F6.3,4HDEG..8X))

2240 640 FORMAT(13X,3(F6.3,4HDEG..8X))

2250 641 FORMAT(13X,2(F6.3,4HDEG..8X))

2260 642 FORMAT(13X,F6.3,4HDEG..)

2270 643 FORMAT(1X,8HVELOCITY,2X,7(4HDRAG,5X,4HLIFT,5X))

2280 644 FORMAT(1X,8HVELOCITY,2X,6(4HDRAG,5X,4HLIFT,5X))

2290 645 FORMAT(1X,8HVELOCITY,2X,5(4HDRAG,5X,4HLIFT,5X))

2300 646 FORMAT(1X,8HVELOCITY,2X,4(4HDRAG,5X,4HLIFT,5X))

2310 647 FORMAT(1X,8HVELOCITY,2X,3(4HDRAG,5X,4HLIFT,5X))

2320 648 FORMAT(1X,8HVELOCITY,2X,2(4HDRAG,5X,4HLIFT,5X))

2330 649 FORMAT(1X,8HVELOCITY,2X,1(4HDRAG,5X,4HLIFT,5X))

2340 650 FORMAT(1X,8HVELOCITY,2X,7(4H...5X,4H...5X))

2350 651 FORMAT(1X,8HVELOCITY,2X,6(4H...5X,4H...5X))

2360 652 FORMAT(1X,8HVELOCITY,2X,5(4H...5X,4H...5X))

2370 653 FORMAT(1X,8HVELOCITY,2X,4(4H...5X,4H...5X))

2380 654 FORMAT(1X,8HVELOCITY,2X,3(4H...5X,4H...5X))

2390 655 FORMAT(1X,8HVELOCITY,2X,2(4H...5X,4H...5X))

2400 656 FORMAT(1X,8HVELOCITY,2X,1(4H...5X,4H...5X))

2410 657 FORMAT(1X,F6.3,3X,2(F6.3,3X,F6.3,3X))

2420 658 FORMAT(1X,F6.3,3X,3(F6.3,3X,F6.3,3X))

2430 659 FORMAT(1X,F6.3,3X,4(F6.3,3X,F6.3,3X))

2440 660 FORMAT(1X,F6.3,3X,5(F6.3,3X,F6.3,3X))

2450 661 FORMAT(1X,F6.3,3X,6(F6.3,3X,F6.3,3X))

2460 662 FORMAT(1X,F6.3,3X,7(F6.3,3X,F6.3,3X))

2470 663 WRITE(6,618)

2480 664 WRITE(6,618)

2490 665 WRITE(6,604)

2500 666 CONTINUE

2510 667 WRITE(6,605) DB

2520 668 WRITE(6,606) DAI

2530 669 WRITE(6,617) VB

2540 670 WRITE(6,607) LB

2550 671 WRITE(6,608) LA

2560 672 WRITE(6,609) CDB1

2570 673 WRITE(6,610) CDB2

2580 674 WRITE(6,611) CDA

2590 675 WRITE(6,627) CDAPK

2600 676 WRITE(6,629) WPAK

2610 677 WRITE(6,618)

2620 678 WRITE(6,612) UWINDK

2630 679 WRITE(6,618)

2640 680 N=NFOSB

2650 681 IF(N.EQ.8) GO TO 86

2660 682 WRITE(6,608)

2670 683 WRITE(6,618)

2680 684 WRITE(6,601) (FOSB(K),K=1,N)

2690 685 WRITE(6,602) (VOSB(K),K=1,N)

2700 686 WRITE(6,618)

2710 687 IF(INCUR.EQ.8) GOTO 88

2720 688 WRITE(6,618)

2730 689 WRITE(6,613)

2740 690 WRITE(6,614)

2750 691 WRITE(6,615) (XX(I),I=1,NCUR)

2760 692 WRITE(6,618)

2770 693 IF(INCUR.EQ.8) GO TO 98

2780 694 WRITE(6,619)

2790 695 WRITE(6,618)

2800 696 WRITE(6,619)

2810 697

2820

2830

2840

2850

2860

2870

2880

2890

2900

2910

2920

2930

2940

2950

2960

2970

2980

2990

3000

3010

3020

3030

3040

3050

3060

3070

3080

3090

3100

3110

3120

3130

3140

3150

3160

3170

3180

3190

3200

3210

3220

3230

3240

3250

3260

3270

3280

3290

3300

3310

3320

3330

3340

3350

3360

3370

3380

3390

3400

3410

3420

3430

3440

3450

3460

3470

3480

3490

3500

3510

3520

3530

3540

3550

3560

3570

3580

3590

3600

3610

3620

3630

3640

3650

3660

3670

3680

3690

3700

3710

3720

3730

3740

3750

3760

3770

3780

3790

3800

3810

3820

3830

3840

3850

3860

3870

3880

3890

3900

3910

3920

3930

3940

3950

3960

3970

3980

3990

4000

4010

4020

4030

4040

4050

4060

4070

4080

4090

4100

4110

4120

4130

4140

4150

4160

4170

4180

4190

4200

4210

4220

4230

4240

4250

4260

4270

4280

4290

4300

4310

4320

4330

4340

4350

4360

4370

4380

4390

4400

4410

4420

4430

4440

4450

4460

4470

4480

4490

4500

4510

4520

4530

4540

4550

4560

4570

4580

4590

4600

4610

4620

4630

4640

4650

4660

4670

4680

4690

4700

4710

4720

4730

4740

4750

4760

4770

4780

4790

4800

4810

4820</

```

2743 WRITE(6,618)
2750 90 WRITE(6,616) UMAX,UMIN
2760 WRITE(6,618)
2770 WRITE(6,623)
2780 WRITE(6,624)
2790 DO 91 K=1,NCAB
2800 WRITE(6,625) K,FLC(K),TREF(K),DCI(K),WC(K),CDC(K),P(K),
&CVFAC(K),CDABD(K),WBD(K),NBOD(K)
2810 CONTINUE
2820 91 WRITE(6,630)
2830 DO 95 K=1,NCAB
2840 N=NAE(K)
2850 IF(N.GT.1) GO TO 93
2860 WRITE(6,631) K,AE(K,1)
2870 GO TO 95
2880 93 WRITE(6,632) K,(FAE(K,I),I=1,N)
2890 WRITE(6,633) (AE(K,I),I=1,N)
2900 95 CONTINUE
2910 IF(NTAB.LE.0) GO TO 112
2920 DO 111 N=1,NTAB
2930 WRITE(6,634) N
2940 NT=NU(N)
2950 GO TO (96,98,100,102,104,106,108) , NPHI(N)
2960 96 WRITE(6,641) PHIM(N,1)
2970 WRITE(6,648)
2980 WRITE(6,655)
2990 DO 97 I=1,NT
3000 WRITE(6,656) U(N,I),D(N,I,1),L(N,I,1)
3010 97 GO TO 111
3020 98 WRITE(6,640) (PHIM(N,J),J=1,2)
3030 WRITE(6,644)
3040 WRITE(6,647)
3050 WRITE(6,654)
3060 DO 99 I=1,NT
3070 WRITE(6,657) U(N,I),D(N,I,J),L(N,I,J),J=1,2)
3080 99 GO TO 111
3090 100 WRITE(6,639) (PHIM(N,J),J=1,3)
3100 WRITE(6,645)
3110 WRITE(6,653)
3120 DO 101 I=1,NT
3130 101 WRITE(6,658) U(N,I),D(N,I,J),L(N,I,J),J=1,3)
3140 GO TO 111
3150 102 WRITE(6,638) (PHIM(N,J),J=1,4)
3160 WRITE(6,646)
3170 WRITE(6,652)
3180 DO 103 I=1,NT
3190 103 WRITE(6,659) U(N,I),D(N,I,J),L(N,I,J),J=1,4)
3200 GO TO 111
3210 104 WRITE(6,637) (PHIM(N,J),J=1,5)
3220 WRITE(6,644)
3230 WRITE(6,651)
3240 DO 105 I=1,NT
3250 105 WRITE(6,660) U(N,I),D(N,I,J),L(N,I,J),J=1,5)
3260 GO TO 111
3270 106 WRITE(6,636) (PHIM(N,J),J=1,6)
3280 WRITE(6,643)
3290 WRITE(6,650)
3300 DO 107 I=1,NT
3310 107 WRITE(6,661) U(N,I),D(N,I,J),L(N,I,J),J=1,6)
3320 GO TO 111
3330 108 WRITE(6,635) (PHIM(N,J),J=1,7)
3340 WRITE(6,642)
3350 WRITE(6,649)
3360 DO 109 I=1,NT
3370

```

[illegible]

```

4810 205 FORMAT(1N1,16ITERATION NUMBER,1X,13)
4820 206 FORMAT(1X,36HTNE TOTAL WEIGHT OF BOTTOM WEIGHT IS,
4830 207 41X,F9.5,1X,4HLBS.)
4840 208 FORMAT(1X,45HTNE COMPUTED VERTICAL COMPONENT OF TENSION IS,1X,F9.5
4850 209 41X,4HLBS.)
4860 210 FORMAT(1X,38HTNE TOTAL DRAG OF THE BOTTOM WEIGHT IS,
4870 211 41X,F9.5,1X,4HLBS.)
4880 212 FORMAT(1X,47HTNE COMPUTED HORIZONTAL COMPONENT OF TENSION IS,1X,
4890 213 4F9.5,1X,4HLBS.)
4900 214 FORMAT(1N1,78N*CONFIGURATION OF THE LOWER ARRAY. POINT (#,B,B,B)
4910 215 4 IS THE BOTTOM)
4920 216 FORMAT(1X,5X,6W S(FT),8X,5HX(FT),8X,5HY(FT),6X,8PHI(DEG),
4930 217 46X,8NPSI(DEG))
4940 218 FORMAT(1X,3X,F9.2,415X,F8.2))
4950 219 FORMAT(1X,18HTNE ANGLE THETA IS,1X,F5.2,1X,8NDEGREES.)
4960 220 FORMAT(1X,48HTNE MAXIMUM PERPENDICULAR DISTANCE FROM CHORD IS,1X,F
4970 221 45.2,1X,5FEET.)
4980 222 FORMAT(1X,15HTNE BOTTOM ANGLE IS,1X,F7.2,5X,17HTNE BOTTOM TENSION IS,1X,
4990 223 4 F8.2)
5000 224 FORMAT(1X,13,3X,F11.7,F11.7,9F11.5)
5010 225 FORMAT(1X,42NREVERSAL IN SIGN BETWEEN DELTAU AND ERRORH)
5020 226 FORMAT(1X,28NSTART OF SIMULTANEOUS SCHEME)
5030 227 FORMAT(1X,25NSTART OF STAGGERED SCHEME)
5040 228 FORMAT(118X,24NCOMPUTED BODY PROPERTIES)
5050 229 FORMAT(1X,3X,F9.2,5X,F8.2,5X,F9.2,4X,F8.2,5X,F8.2,6X,
5060 230 4 F8.2,6X,F8.4,6X,F8.3,6X,F8.3)
5070 231 FORMAT(1X,3X,F8.2,5X,F8.2,5X,F8.2,5X,F8.2,5X,F8.2,6X,
5080 232 4 F8.2,6X,F8.4,7X,5H*BODY,13.5X,8HMO LIFT*)
5090 233 WRITE(6,282)
5100 234 WRITE(6,341)
5110 235 DOLLIMIT-DLIMIT
5120 236 UDDMIN-UDMIN
5130 237 VBOT-VBD(NCAB)
5140 238 GPRSO-CANNA*PI*.25*DB*DB
5150 239 CPIOV4-CANNA*PI*.25
5160 240 ILAST=B
5170 241 HMIN-VB/GPRSO
5180 242 UDRIFT-UDMIN*B,S*(DLIMIT-UDDMIN)
5190 243 DLIMIT-1.2*DLIMIT
5200 244 LET INITIAL BUOYANCY BE THE WEIGHT OF EVERYTHING UNDER THE BUOY.
5210 245 XNPHS=NPHS
5220 246 DELTA=1.
5230 247 BCY=B.
5240 248 DO 253 J=1,NCAB
5250 249 BCY=BCY*FLC(J)*WC(J)*VBD(J)
5260 250 CONTINUE
5270 251 BCY=BCY*VPK*TSV
5280 252 IF(BCY.LE.-B.) BCY=B.
5290 253 H=(BCY*VB)/GPRSO
5300 254 UMAX=DLIMIT
5310 255 UMIN=UDDMIN
5320 256 UMIN1=UMIN
5330 257 UMAX1=UMAX
5340 258 WRITE(6,282)
5350 259 PRV=B.
5360 260 PRH=B.
5370 261 ABSRH=B.
5380 262 ABSRV=B.
5390 263 PERH=15.
5400 264 PERV=15.
5410 265 EPRIME=100.
5420 266 BRSLT=EPRIME
5430 267 DENO-LB=CDB1*DB*CDAPK
5440 268 DO 2# J=1,NCAB

```

Copy available to DTIC does not permit fully legible reproduction

```

5260 VPLB=VCB(J)
5270 TREFC=TREF(J)
5280 JAM=J
5290 PC=P(J)
5300 FNP=NPR(J)
5310 SPA=FLC(J)/FNP
5320 N1=NLAST+2
5330 NLAST=N1+NPR(J)-1
5340 DO 250 M=N1,NLAST
5350 MINDEX=M
5360 V(1)=T(M-1)
5370 V(2)=PHI(M-1)
5380 V(3)=X(M-1)
5390 V(4)=Y(M-1)
5400 V(5)=SE(M-1)
5410 SS=SN(M-1)
5420 CALL KUTHER(5,SS,V(5),EPSLON,SPA,START,HCX,EP2)
5430 T(M)=V(1)
5440 PHI(M)=V(2)
5450 PHID(M)=PHI(M)*RADIAN
5460 IF(KIT-1) 952,951,952
5470 951 IF((PHID(M).GT.125.) .AND. (K2.LE.4)) GO TO 888
5480 952 IF((PHID(M).LT.8.) .AND. (K2.LE.4)) GO TO 828
5490 952 X(M)=V(3)
5500 Y(M)=V(4)
5510 SE(M)=V(5)
5520 S(M)=SS
5530 288 CONTINUE
5540 CALL CUR(V(NLAST),COFY)
5550 CREL=COFY-UDRIFT
5560 IF(NBOD(J).LE.8) GO TO 3888
5570 CALL BODY(CREL,PHID(NLAST),CDABD(J),NBOD(J),VBD(J),FLIFT(J),BDRAG(
5580 &),IRUN,JAM)
5590 3888 DRAGH=8.5*HO*CDABD(J)*CREL*ABS(CREL)
5600 XCOMP=DRAGH+T(NLAST)*COS(PHI(NLAST))
5610 YCOMP=VBD(J)+T(NLAST)*SIN(PHI(NLAST))
5620 T(NLAST+1)=SORT(XCOMP**2+YCOMP**2)
5630 PHI(NLAST+1)=ATAN2(YCOMP,XCOMP)
5640 PHID(NLAST+1)=PHI(NLAST+1)*RADIAN
5650 X(NLAST+1)=X(NLAST)
5660 Y(NLAST+1)=Y(NLAST)
5670 S(NLAST+1)=S(NLAST)
5680 SE(NLAST+1)=SE(NLAST)
5690 248 CONTINUE
5700 95 MPRINT=NLAST
5710 THORIZ=T(MPRINT)*COS(PHI(MPRINT))
5720 TVERT=T(MPRINT)*SIN(PHI(MPRINT))
5730 CALL CUR(V(MPRINT),COFY)
5740 12MANY=8
5750 CREL=COFY-UDRIFT
5760 VBOT=VBD(NCAB)
5770 DRAGBT=8.5*HO*CDABD(NCAB)*CREL*ABS(CREL)
5780 IF(ABS(DRAGBT).LT.8.881) DRAGBT=8.881
5790 95 CHECK BOTTOM CONDITIONS WITH REALITY.
5800 PPERV=PRV
5810 PPERN=PRN
5820 ERRORV=TVERT-VBOT-TBV
5830 ERRORN=THORIZ+DRAGBT-TBN
5840 PRV=ERRORV
5850 PRN=ERRORN
5860 ABSERV=ABS(ERRORV)
5870 ABSERN=ABS(ERRORN)
5880 RESULT=ABS(ERRORN**2+ERRORV**2)
5890 799 RATIO1=ABS(ERRORN/DRAGBT)

```

```

5980 RATIO2=ABS(ERRORV/(VBOT+TBV))
5981 DRGTBH=DRAGBT+TBH
5982 RATIO3=ABS(ERRORH/DRGTBH)
5983 WRITE(6,202)
5984 WRITE(6,216)INO,UDKNTS,HTMP,DRAGBT,VBOT,ERRORH,ERRORV,T(MPRINT),
5985 &PHID(MPRINT),DRAGB,BCY,DELTA
5986 IF (RESULT-BRSLT) 903,903,906
5987 BH=H
5988 BUDR=UDRIFT
5989 BRSLT=RESULT
5990 IF ((RATIO3.LE..02).AND.(RATIO2.LE..02)) GO TO 150
5991 IF (ABS(DRGTBH)-0.30) 2055,2055,2056
5992 2055 IF ((RATIO3.LE..01).AND.(RATIO2.LE..02)) GO TO 150
5993 CONTINUE
5994 IRUN=IRUN+1
5995 IWO=IRUN
5996 UTEMP=UDRIFT
5997 IF (IRUN.GT.1) GO TO 150
5998 IF (IRUN.GT.50) GO TO 111
5999 GO TO 112
6000 IF (F-ERRORH) 139,960,139
6001 F=ERRORH
6002 IF (INO.GT.400) GO TO 960
6003 IF (KIT-1) 4860,650,4860
6004 IF (KIT-2) 120,121,121
6005 KUD=KUD+1
6006 IF ((RATIO3.LE..02)) GO TO 102
6007 IF (KUD.GT.KUSTOP).AND.(RATIO2.GT..02)) GO TO 102
6008 IF ((PRH/PPERH).GT.1.).AND.(KUD.GE.2)) GO TO 2040
6009 IF ((RATIO3.LE..02).AND.(KIT.EQ.0)) GO TO 1651
6010 IF (KUD.GT.KUSTOP).AND.(KIT.EQ.0)) GO TO 1651
6011 IF (ERRORH.GT..0.0) GO TO 100
6012 UDRIFT=.5*(UDRIFT+UMIN)
6013 UMAX=UTEMP
6014 GO TO 2
6015 UDRIFT=.5*(UDRIFT+UMAX)
6016 UMIN=UTEMP
6017 GO TO 2
6018 KH=KH+1
6019 KUD=0
6020 WRITE(6,202)
6021 IF ((-ERRORV/PRERV).GT..0.5) DHFAC=.5*DNFAC
6022 IF (ERRORV/PRERV).GT..0.7) DHFAC=1.5*DNFAC
6023 PRERV=ERRORV
6024 IF (ERRORV.GT..0.0).AND.(PHID(MPRINT).LT.100.)) GO TO 2002
6025 H=HTMP+DNFAC*ABSERV/CPBSQ
6026 IF (H.GE.HMAXP) H=HTMP+.75*(HMAXP-HTMP)
6027 HNT=H/HTMP
6028 HTH=HTMP/H
6029 HMINP=HTMP
6030 UMAX=(HNT+.05)*UDRIFT
6031 UNIN=(HNT-.05)*UDRIFT
6032 GO TO 2032
6033 H=HTMP-DHFAC*ABS(ERRORV)/CPBSQ
6034 IF (H.LT.(0.5*(HTMP+HMIN))) H=.5*(HTMP+HMIN)
6035 IF (H.LE.HMINP) H=HTMP-.75*(HTMP-HMINP)
6036 HMAXP=HTMP
6037 HNT=H/HTMP
6038 HTH=HTMP/H
6039 UMAX=(HNT+.05)*UDRIFT
6040 UNIN=(HNT-.05)*UDRIFT
6041 PREVM=HTMP
6042 PREVU=UDRIFT
6043 UDRIFT=.5*(UDRIFT

```

```

6540 UMAX1=UMAX
6550 UMIN1=UMIN
6560 GO TO 2
6570 2040 KREV=KREV+1
6580 IF(KREV.GT.10) GO TO 960
6590 WRITE(6,220)
6600 GO TO 303
6610 KIT=1
6620 UDI=UDRIFT
6630 HI=H
6640 EVI=ERRORV
6650 UMAX=UMAX+ABS(ERRORV)*UDRIFT*.03
6660 UMIN=UMIN-ABS(ERRORV)*UDRIFT*.03
6670 IF(VBOT.LT.0.) GO TO 1001
6680 WRITE(6,202)
6690 WRITE(6,222)
6700 GO TO 650
6710 99 FIRST=-100
6720 DO 97 I=1,MPRINT
6730 CALL CUR(Y(I),COFY)
6740 FIRST=100
6750 CRELKT(I)=(COFY-UDRIFT)*0.5924
6760 PHIV(I)=90.0-PHID(I)
6770 CONTINUE
6780 97 FIRST=-100
6790 HALF=.5*HTEMP
6800 CALL CUR(HALF,COFY)
6810 FHALF=(COFY-UDRIFT)*.5924
6820 FIRST=100
6825C
6830 WRITE(6,205) INO
6840 WRITE(6,200) UDKNTS
6850 WRITE(6,209) DRAGB
6860 WRITE(6,201) HTEMP
6870 WRITE(6,207) BCY
6880 WRITE(6,219) FHALF
6890 219 FORMAT(1X,"FLOW PAST THE SURFACE UNIT IS",F8.4,1X,"KNOTS")
6900 WRITE(6,224) CDBI
6910 224 FORMAT(1X,"CD OF SURFACE UNIT IS",F8.4)
6920 WRITE(6,202)
6930 WRITE(6,230)
6940 WRITE(6,203)
6950 I=0
6960 K=0
6970 80 I=I+1
6980 IF(I.GE.MPRINT)GO TO 81
6990 IF(S(I).GE.S(I+1))GO TO 81
7000 WRITE(6,204)S(I),SE(I),X(I),Y(I),PHID(I),T(I),PHIV(I),CRELKT(I)
7010 GO TO 80
7020 K=K+1
7030 81 IF(NBOD(K).LE.0)GO TO 83
7040 WRITE(6,231)S(I),SE(I),X(I),Y(I),PHID(I),T(I),PHIV(I),CRELKT(I),FL
7050 &IFT(K),BDAG(K)
7060 GO TO 87
7070 83 WRITE(6,232)S(I),SE(I),X(I),Y(I),PHID(I),T(I),PHIV(I),CRELKT(I),K
7080 87 IF(I.LT.MPRINT)GO TO 80
7090 WRITE(6,202)
7100 TOTV=VBOT+TBV
7110 WRITE(6,206) TOTV
7120 WRITE(6,207) TVERT
7130 WRITE(6,202)
7140 TOTM=DRAGBT+TBM
7150 WRITE(6,208) TOTM
7160 WRITE(6,209) THDRIZ

```

```

7165C
7170 GO TO 138
7180 K2=0
7190 IF((IRUN.GT.35).AND.(RESULT.GT.EPRIME).AND.(EPRIME.GT.8.28)) GO
7200 TO 1881
7210 IF(RESULT.GT.EPRIME) GO TO 668
7220 PERV=ERRORV
7230 PERH=ERRORH
7240 EPRIME=RESULT
7250 PUDRFT=UDRIFT
7260 PH=H
7270 DELTA=1.
7280 USEN=1.
7290 DELTAH=-DELTA*ABSERV*ERRORV/(RESULT*CPABSO)
7300 DELTAU=USEN*DELTA*ERRORH*ABSERH/(RESULT*DENS)
7310 DELTAU=DELTAU/UDRIFT
7320 IF(DELTAU) 651.651.652
7330 UMAX=UDRIFT
7340 UMIN=UDRIFT*DELTAU
7350 GO TO 653
7360 UMAX=UDRIFT*DELTAU
7370 UMIN=UDRIFT
7380 UDRIFT=UDRIFT*DELTAU
7390 H=H*DELTAH
7400 HINT=8.7
7410 IF(H.LT.(HTEMP-HINT*(HTEMP-HMIN))) H=(HTEMP-HINT*(HTEMP-HMIN))
7420 GO TO 2
7430 IF((DELTA.LT.8.85).OR.(USEN.GT.588.)) GO TO 981
7440 IF((DELTA.LT.8.3).AND.(IRUN.LT.25)) GO TO 981
7450 IF(EPRIME.LT.8.1.AND.IRUN.LT.38) GO TO 981
7460 EPH=PRH/PERH
7470 IF((EPH.GT.1.).AND.(ABS(PRH).GT.ABS(PRV))) GO TO 981
7480 AEPH=ABS(EPH)
7490 ERRORH=PERH
7500 ERRORV=PERV
7510 ABSERV=ABS(ERRORV)
7520 ABSERH=ABS(ERRORH)
7530 RESULT=EPRIME
7540 UDRIFT=PUDRFT
7550 H=PH
7560 ARVPV=ABS(PRV/PERV)
7570 DELTA=8.5*DELTA
7580 USEN=1.
7590 GO TO 987
7600 KIT=5
7610 HTEMP=H1
7620 UTEMP=UD1
7630 UDRIFT=UD1
7640 ERRORV=EV1
7650 KUD=8
7660 WRITE(6.282)
7670 WRITE(6.223)
7680 GO TO 182
7690 IB=15
7700 H=8H
7710 UDRIFT=BUDR
7720 GO TO 2
7730 UMAX=UDRIFT
7740 IZMANY=IZMANY+1
7750 MPRINT=MINDEX
7760 IF(IZMANY.GT.7) GO TO 962
7770 UDRIFT=.5*(UDRIFT+UMIN)
7780 GO TO 2
7790 UMIN=UDRIFT

```

```

7888      12MANY=12MANY+1
7889      MPRINT=MINDEX
7890      IF(12MANY.GT.7) GO TO 962
7891      UDRIFT=.5*(UDRIFT+UMAX)
7892      GO TO 2
7893      K2=K2+1
7894      K3=K3+1
7895      IF(K3.GT.15) GO TO 1881
7896      12MANY=8
7897      UMAX=UMAX+.83*UDRIFT
7898      UMIN=UMIN-.83*UDRIFT
7899      GO TO 2
7900      ILAST=18
7901      GO TO 99
7902      XX(1)=.8
7903      VY(1)=.8
7904      SAR(1)=.8
7905      BPHI(1)=PHID(MPRINT)
7906      IF(NHPS.LE.1) GO TO 133
7907      IARRAY=NHPS
7908      DO 255 MK=1,NHPS
7909      KK=MK-1
7910      NMKK=NCAB-KK
7911      IARRAY=IARRAY+NPR(NMKK)
7912      DO 131 I=1,IARRAY
7913      II=MPRINT-I
7914      EPHI(I+1)=PHID(II)
7915      XX(I+1)=X(MPRINT)+X(II)
7916      VY(I+1)=Y(MPRINT)+V(II)
7917      SAR(I+1)=S(MPRINT)+S(II)
7918      CONTINUE
7919      THETA1=ATAN2(VY(IARRAY+1),XX(IARRAY+1))
7920      THETA2=98.8-RADIAN*THETA1
7921      RMAX=.8
7922      I32=IARRAY+1
7923      DO 132 I=2,132
7924      R=SQRT(XX(I)**2+VY(I)**2)
7925      THETA2=ATAN2(VY(I),XX(I))
7926      Z=R*ABS(SIN(THETA2-THETA1))
7927      IF(Z.GT. RMAX) RMAX=Z
7928      CONTINUE
7929      DO 140 I=1,132
7930      BPHI(I)=98.8-BPHI(I)
7931      CONTINUE
7932      WRITE(6,282)
7933      WRITE(6,213) THETA2
7934      WRITE(6,214) RMAX
7935      CONTINUE
7936      RETURN
7937      END
7938
7939      THIS ROUTINE CALCULATES FLOW FOR A GIVEN DEPTH.
7940      SUBROUTINE CUR(X,FOFX)
7941      COMMON /BLK2/ XX(38), VY(38), NCUR
7942      COMMON /BLK3/ FIRST
7943      IF(NCUR.EQ.0) GO TO 85
7944      IF(FIRST.LT.8.8) I=1
7945      IF(X.LT.8.8) GO TO 88
7946      IF((X-GE.XX(I)).AND.(X.LE.XX(I+1))) GO TO 38
7947      IF((X-GE.XX(I-1)).AND.(X.LE.XX(I))) GO TO 48
7948      IF((X-GE.XX(I+1)).AND.(X.LE.XX(I+2))) GO TO 58
7949      I=J
7950      IF(X.LE.XX(I+1)) GO TO 38
7951      I=I+1

```

```

8420 30 GO TO 20
8430 FOFX=VV(I)*((VV(I+1)-VV(I))/(XX(I+1)-XX(I)))*(X-XX(I))
8440 RETURN
8450 40 I=I+1
8460 GO TO 30
8470 50 I=I+1
8480 GO TO 30
8490 FOFX=VV(I)
8500 RETURN
8510 85 XM=X*.3848
8520 IF(XM.GT.45.6.AND.XM.LT.1888.) GO TO 86
8530 IF(XM.GE.1888.) GO TO 87
8540 A=(77/(130.-XM))
8550 B=(45.6/(XM*.882))
8560 VM=A+.836*A*LOG(B)
8570 GO TO 88
8580 86 VM=(77/(130.-XM))
8590 GO TO 88
8600 87 VM=.868
8610 88 FOFX=VM*3.2886
8620 RETURN
8630 END
8640
8650 SUBROUTINE DAUX(S,IN,DE)
8660 DIMENSION DE(5)
8670 COMMON /ELK4/ DRAG,WPLA,WPLB,FFTTANG,DRIFT,TREFC,PC
8680 COMMON /ELK7/ FAE(100,15),AE(100,15),NAE(100),JAM
8690 PEAL IN(5)
8700 CALL CUR(IN(4),COFY)
8710 IF(NAE(JAM).EQ.1) AEC=AE(JAM,1)
8720 IF(NAE(JAM).GT.1) CALL STRETH(IN(1),AEC)
8730 CREL=COFY-DRIFT
8740 CADSC=CREL*ABS(CREL)
8750 E=(IN(1)-TREFC)/AEC
8760 DE(5)=1.+E
8770 PCE=.1/(1.+E)**PC
8780 DRAP=DRAG*PCE
8790 F2=PCE*PCE*DE(5)
8800 WPL=WPLA-WPLB*F2
8810 LE(3)=COS(IN(2))*DE(5)
8820 DE(4)=SIN(IN(2))*DE(5)
8830 DE(1)=CPAP*CADSC*SIGN(FFTTANG,COS(IN(2)))*DE(5)-WPUL*SIN(IN(2))
8840 DE(2)=(DPAF-CADSC*SIN(IN(2))*ABS(SIN(IN(2)))*DE(5))+VPUL*
8850 ACOS(IN(2))/IN(1)
8860 RETURN
8870 END
8880
8890 SUBROUTINE KUTMER(N,T,VQ,EPS,H,FIRST,HGX,A)
8900 KUTMER ROUTINE REVISED FOR IVODE JAN 30,1964
8910 DIMENSION V2(23),V1(23),V2(23),F1(23),F2(23)
8920 IF(FIRST)20,10,20
8930 HC=H
8940 :PLOC=1
8950 FIRST=1.
8960 LOC=0
8970 HCX=HC
8980 CALL DAUX (T,V0,F0)
8990 DO 40 I=1,N
9000 V1(I)=V0(I)*(HC/3.)*F0(I)
9010 CALL DAUX (T+HC/3.,V1,F1)
9020 DO 50 I=1,N
9030 V1(I)=V0(I)*(HC/6.)*F0(I)+(HC/6.)*F1(I)
9040 CALL DAUX (T+HC/3.,V1,F1)
9050 DO 60 I=1,N
9060
9070
9080
9090
9100
9110
9120
9130
9140
9150
9160
9170
9180
9190
9200
9210
9220
9230

```

[illegible]



```

10092 IF(FLOWK.LE.0.) GO TO 30
10093 IF(FLOWK.LT.VOSB(1)) GO TO 11
10094 IF(FLOWK.GT.VOSB(N)) GO TO 12
10095 I=1
10096 IF(FLOWK.LE.VOSR(I+1)) GO TO 10
10097 I=I+1
10098 GO TO 5
10099 F2=FOSB(1)+(FOSB(1+1)-FOSB(1))/(VOSB(1+1)-VOSB(1))*
10100 &FLOW-VOSB(1)
10101 GO TO 13
10102 F2=FOSB(1)
10103 GO TO 13
10104 F2=FOSB(N)
10105 CD1=2=F2/(1.9985*FLOW*FOSB(1)+FOSB(1))
10106 EDPRG=F2-F1
10107 IF(ABS(EDPRG).LE.001) GO TO 30
10108 IF(F2-F1).16.16.17
10109 CD=CD1-ABS((CD1-CD1)/2)
10110 GO TO 35
10111 CD=CD1+ABS((CD1-CD1)/2)
10112 GO TO 35
10113 CD=CD1
10114 RETURN
10115 END
10116
10117 THIS ROUTINE CALCULATES AE GIVEN FORCE VALUES.
10118 SUBROUTINE STRETHIX(AEC)
10119 COMMON /BLK7/ FAE(100,15),AE(100,15),NAE(100),JAM
10120 J=JAM
10121 N=NAE(J)
10122 IF(Y.LE.FAE(J,1)) GO TO 80
10123 IF(Y.GE.FAE(J,N)) GO TO 90
10124 I=1
10125 IF(Y.LE.FAE(J,1+1)) GO TO 70
10126 I=I+1
10127 GO TO 30
10128 AEC=AE(J,1)+AE(J,1+1)-AE(J,1)/(FAE(J,1+1)-FAE(J,1))*
10129 &(Y-FAE(J,1))
10130 RETURN
10131 AEC=AE(J,1)
10132 RETURN
10133 AEC=AE(J,N)
10134 RETURN
10135 END
10136

```